

April 10, 2002

### Dear Stakeholder

The Rocky Flats Cleanup Agreement (RFCA) Stakeholder Focus Group will meet at the Broomfield Municipal Center at One DesCombes Drive on April 17, 2002 from 3 30 to 6 30 p m

The agenda for the April 17 meeting is enclosed (Attachment A) We will discuss the following topics

- Agency Responses to RSALs Task 3 Report Peer Reviews
- RESRAD and Risk Recalculations
- Uranium Surface RSAL Calculation and Draft Modeling Results

The handouts from the March 20, 2002 RFCA Focus Group meeting are enclosed as Attachment B, and include

Agency Response presentations to RSALs Task 3 Report Peer Reviews

Attachment C is the RSALs Working Group Meeting Notes for the March 28, April 4 and April 11, 2002 meetings

Also attached (Attachment D) are two documents that were developed by the RSALs Working Group meeting of April 11, 2002 Please read the following attached materials for the April 17 meeting

- Draft RSAL Recalculations Responding To Task 3 Comments And Quality Checks (RESRAD Dose Calculations Only), and
- Draft Addendum To Task 3 Report Computations Of RSALs For Uranium Contamination At Rocky Flats Using RESRAD 6 0 (Dose-Based Computations)

Attachment E is the October 3, 2001 meeting minutes

You may call either Christine or me if you have any questions comments, or suggestions concerning the RFCA Stakeholder Focus Group or the upcoming meeting

Sincerely,

C Reed Hodgin CCM

Facilitator / Process Manager

SW-A-004496

ADMIN RECORD



### RFCA Stakeholder Focus Group Attachment A

Title Agenda for April 17, 2002 Focus Group Meeting

Date April 12, 2002

Author C Reed Hodgin

AlphaTRAC, Inc

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### RFCA Stakeholder Focus Group Meeting Agenda

When <sup>.</sup>	April 17, 2002 3:30 - 6·30 p.m.
Where:	Broomfield Municipal Hall, Bal Swan and Zang's Spur Rooms
3 30-3 40	Ground Rules, Agenda Review, Objectives for this Meeting
3 40-4 25	Agency Response to RSALs Task 3 Peer Reviews - Presentation and Group Discussion
4 25-5 10	RESRAD and Risk Recalculation - Presentation and Group Discussion
5 10-5 20	Break
5 20–6 20	Uranium Surface RSAL Calculation and Draft Modeling Results - Presentation and Group Discussion
6 20-6 30	Set Next Agenda
6 30	Adjourn

### RFCA Stakeholder Focus Group Attachment B

Title March 20, 2002 RFCA Focus Group Meeting

Presentations and Handouts, including

Agency Response presentations to RSALs

Task 3 Report Peer Reviews

Date April 12, 2002

Phone Number (303) 428-5670

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### Cancer Slope Factors

- Comment: Cancer slope factors are for mixed age populations and should not be used for adult only
  - calculations for scenarios with only adults (i.e., wildlife refuge workers and office workers) using adult specific cancer slope factors Response: We will rerun scenarios

# Addition of Point Estimates

- Comment: Point estimates should be provided to provide perspective to probabilistic estimates
- refuge workers (the open space and Response: Point estimates will be provided for residential and wildlife office worker scenarios are already point estimates)

### Additional Probabilistic Assessments

- Comment: Probabilistic assessments
- workgroup decision was made to focus on Response: Development of probabilistic the scenarios, pathways, and parameters inputs is time and resource intensive. A should also be done for the open space which would most impact the risk and and office worker scenarios decision making process

### Adult Soil Intake Rates

- does not seem reasonable because it is a point estimates for variables with sparse data, instead of assigning distributions, Comments: The adult soil intake rate single value and it is high. The use of deliberately interjects bias.
  - use a distribution for the adult soil intake Response: The report will be revised to agricultural workers, will be provided for rate. A point estimate calculation using the 100 mg/day EPA default value for comparison.

# Childhood Soil Intake Rates

- value (1000 mg/day) can actually be sustained by a child. A value that high reviewer is skeptical how long the max children seem to be reasonable. The **Comment:** The values chosen for seems questionable.
- Comment: The RSAL calculation does observed in a small percentage of not take into account extreme soil ingestion behavior that has been children

# Childhood Soil Intake Rates

- Response: The intent of the RSALs is to provide a level in soil which is protective of continuous, long term exposures.
- with children resulting in occasional days of hıgh soıl intake, however, the annual or long term average is The data suggest that day to day variability occurs much lower.
- representative of Denver Front Range population Anaconda study determined to be most
- Decision to increase max value a workgroup decision based on other suitable studies
- Hot spot methodology in Sampling and Analysis Plans will address risks from acute or short term exposures

### Spreadsheet Analysis

- Comment: Robert Underwood provided a number of suggestions on improving and correcting spreadsheets used in calculating RSALs
- address his comments were they pertain Response: Comments were very good and we will revise spreadsheets to

## Backward Calculation Method

- Comment: The backward calculation method is inappropriate for deriving RSALs
- Response: There are limitations to this method. It should not be used when the variable that is back calculated (i.e., the risk term) is represented by a distribution.
- However, if you set a single target risk level (risk= $10^{-6}$ ), and then algebraically reverse the risk equation, you produce a distribution of RSALs that represents the same source of variability as a forward calculation of risk.
- Each pergentile of the RSAL distribution (e.g., the "x" percentile) corresponds to the 1-x percentile for the distribution of risk estimates.

### Uncertainty and Variability Analysis (Section VI)

- In response to many questions/comments, this section <u>will be revised</u> to the extent possible to
  - Better separate uncertainty from variability (e g , Peer Reviewer 2, comment #4 & #7)
  - Make clear that the input distributions (PDFv) to the RSAL calculations represent variability in the available data, NOT uncertainty (e g, Peer Reviewer 1, comment #2)
  - Clarify the text or those table entries that confused people (e g, Area Correction Factors in RESRAD and Risk equations, Melissa Anderson, comment #12)
  - Correct errors (e g, fire frequency entry in the summary tables, Jerry Henderson, comment #17)
  - Include any additional sources of uncertainty in the tables (e g, uncertainties inherent in the DCFs and CSFs, e g, Peer Reviewer 1, comment #8)
  - Expand discussions, where needed, to increase the clarity of the document (e g, add exposure unit calculations for Wildlife Refuge Worker, Alexander Williams, comment #3)
  - Clearly describe the cumulative impact, for each receptor, of the choices made for all parameters and assumptions (e g, Peer Reviewer 1, comment #2)

- Some areas where the Working Group disagrees with the Reviewers,
   and plans to retain the original approach or apply an alternative
  - Qualitative assessment of the impacts of all sources of uncertainty on the final RSAL calculation.
    - Confidence in data supporting "driver" parameters, will be ranked as "high", "medium" and "low"
    - More consistent qualitative method for evaluating impact of all assumptions on the final RSALs
    - Goal of uncertainty assessment Does the 95<sup>th</sup> percentile of the probabilistic risk distribution (the 5<sup>th</sup> percentile of the probabilistic RSAL distribution) adequately represent the RME individual or not?
    - 2D MCA may have been informative, but
    - complex analysis was beyond the scope of what was needed in this case
    - Quantitative assessment of uncertainty too subjective

- More complete discussion of sources of uncertainty in the dose and risk coefficients (Peer Reviewer 1, comment # 8), but no quantification
  - Even ICRP has not made a quantitative estimate of uncertainty regarding these dose and risk coefficients
  - EPA's ORIA is currently tasked with making estimates of uncertainty for the FGR 13 risk coefficients

- DCFs from ICRP 60-72, rather than ICRP 26-30 (Issue of no regulatory precedent for use of the dose factors from ICRP 60-72 rather than ICRP 30, Alexander Williams, comment # 19)
- ICRP 26-30 methodology will continue to be used for all site compliance calculations, as required by DOE \*\*
  Orders
  - However, ICRP-60-72
    - more precise biokinetic model of the respiratory system
    - more accurate apportionment of dose to the GI tract,
    - reduced uncertainty
  - ICRP 72 dose factors specifically applicable to members of the public, as opposed to workers
  - Models used to develop the ICRP 60-72 dose factors are the same as those used to develop the CSFs from FGR
     13
- Will not develop special dose or risk coefficients pertinent to the RME individual (Peer Reviewer 1, comment #8)
- Validity of point estimates (Peer reviewer 2, comment # 7, 8, LeRoy Moore, comment #8)

### RFCA Stakeholder Focus Group Attachment C

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RSALs Working Group Notes for March 28,

April 4, and April 11, 2002

Date

April 12, 2002

Phone Number

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### **NOTES FROM RSALs WORKING GROUP MEETING ON 3/28/02**

### **ITEMS COVERED ON 3/28**

- 1 Discussed and finalized parameters for U calculations and Pu/Am recalculations
- 2 Discussed preliminary U dose calculations and draft write-up

### **ACTIONS**

Action Item	Who	When	Notes
Revise U write-up and	Jım Benettı	4/1/02	
provide to working group			
Add to U write-up, as	Working group	4/4/02	
appropriate	members		
Provide risk parameter	Susan Griffin/	4/4/02	
spreadsheet to group	Phil Goodrum		
Provide dose parameter	Bob Nininger	4/1/02	
spreadsheet to group			
Make changes for U	Working group	4/4/02	
parameters, as appropriate	members		
Make electronic changes to	Each working	4/19/02 at	
the Task 3 report and e-	group member	the latest	
mail to Mark Aguilar after		(sooner 1f	
ALL changes are made		possible)	
Complete uranium	Jım Benettı	4/10/02	
calculations (dose and risk)	(dose),		
for presentation to Focus	Susan Griffin		
Group on 4/17	(risk)		<u> </u>
Complete plutonium and	Jım Benettı	4/10/02	]
americium dose and risk	(dose),		
recalculations for	Susan Griffin		
presentation to Focus	(risk)		
Group on 4/17			

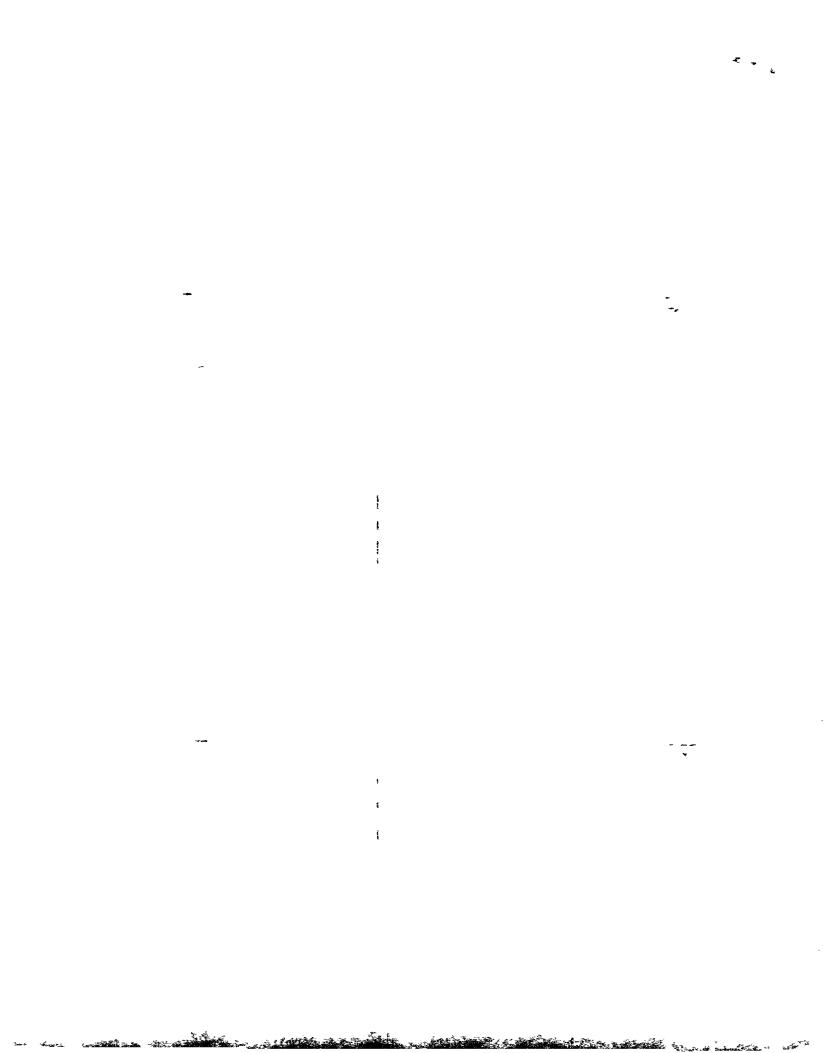
### **DECISIONS**

None

### NEXT MEETING THURSDAY, 4/4/02, 8 30 a m, at Rocky Flats B060, Room 112

### Agenda Items

- 1 Discuss calculations/recalculations that have been completed
- 2 Discuss changes to the Task 3 report



### NOTES FROM RSALs WORKING GROUP MEETING ON 4/4/02

### **ITEMS COVERED ON 4/4**

- 1 Discussed parameters for U calculations and Pu/Am recalculations
- 2 Discussed logistics for editing and finalizing the Task 3 report

### **ACTIONS**

Action Item	Who	When	Notes
Revise U addendum and provide to Sandi	Jım Benettı	4/8/02	
Add to U addendum, as appropriate	Working group members	4/10/02	
Check Pu/Am dose recalculations & provide to Mark & Sandi	Jım Benettı	4/10/02	
Provide risk parameter spreadsheet to group	Susan Griffin/ Phil Goodrum	4/11/02	
Make U changes to dose parameter spreadsheet	Jım Benettı	4/9/02	
Provide Task 3 report web site to working group	Mark Aguılar	4/5/02	
Coordinate with AlphaTrac for 4/17 Focus Group meeting	CDPHE staff	4/10/02	
Make electronic changes to the Task 3 report and e- mail to Mark Aguilar after ALL changes are made	Each working group member	4/19/02 at the latest (sooner if possible)	
Complete uranium calculations (dose and risk) for presentation to Focus Group on 4/17	Jim Benetti (dose), Susan Griffin (risk)	4/10/02	
Complete plutonium and americium dose and risk recalculations for presentation to Focus Group on 4/17	Jim Benetti (dose), Susan Griffin (risk)	4/10/02	

### **DECISIONS**

1 Each working group member will make changes to the original Task 3 report (with tracking changes enabled) and provide their own final revised document to Mark Aguilar Changes from all working group members will be merged into one document, which will be distributed to the working group for review. The working group may choose to review the changes using a computer and overhead at a future working group meeting.

### NEXT MEETING. THURSDAY, 4/11/02, 8:30 a.m., at Rocky Flats B060, Room 112

### Agenda Items

- 1 Discuss calculations/recalculations
- 2 Discuss changes to the Task 3 report.
- 3 Discuss 4/17 Focus Group meeting
- 4 Go through actions

### NOTES FROM RSALs WORKING GROUP MEETING ON 4/11/02

### **ITEMS COVERED ON 4/11**

- 1 Discussed U calculations and Pu/Am recalculations
- 2 Discussed 4/17 Focus Group meeting presentations
- 3 Discussed status of editing and finalizing the Task 3 report

### **ACTIONS**

Action Item	Who	When	Notes
Add plant uptake info to U	Susan Griffin/	4/16/02	
dose addendum and	Phil Goodrum		1
prepare U risk addendum			
Provide risk parameter	Susan Griffin/	4/18/02	
spreadsheet to group	Phil Goodrum	l	
Provide U addendum and	Bob Nininger	4/12/02	
Pu/Am dose recalculations			
to AlphaTrac for Focus			
Group meeting			
Provide U risk calculation	Susan Griffin/	4/16/02	
and Pu/Am risk	Mark Aguılar		
recalculation info to			
AlphaTrac for Focus Group			
meeting			
Send uncertainty topics for	Working group	4/15/02	
revised Task 3 report to	members		
Diane Niedzwiecki			
Make electronic changes to	Each working	4/26/02 at	
the Task 3 report and e-	group member	the latest	
mail to Mark Aguilar after		(sooner if	
ALL changes are made		possible)	
Complete uranium risk	Susan Griffin	4/16/02	
calculations for_			
presentation to Focus			
Group on 4/17			
Complete plutonium and	Susan Griffin	4/16/02	
americium risk			
recalculations for			
presentation to Focus			
Group on 4/17		<u> </u>	

### **DECISIONS**

1 None

### NEXT MEETING THURSDAY, 4/18/02, 8.30 a.m., at CDPHE, HFD Training Room (meet at reception desk in Bldg A)

### Agenda Items.

- 1 Discuss calculations/recalculations
- 2 Discuss changes to the Task 3 report.
- 3 Go through actions

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### RFCA Stakeholder Focus Group Attachment D

Title

April 11, 2002 RSALs Working Group handouts, including

- Draft RSAL Recalculations Responding To Task 3 Comments And Quality Checks (RESRAD Dose Calculations Only), and
- Draft Addendum To Task 3 Report
   Computations Of RSALs For Uranium
   Contamination At Rocky Flats Using RESRAD
   6 0 (Dose Based Computations)

Date

April 12, 2002

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### DRAFT

### RSAL Recalculations Responding to Task 3 Comments and Quality Checks (RESRAD Dose Calculations Only)

Land Use Scenario	Pu RSAL 10/01 Task 3 Report	Pu RSAL 4/02 Task 3 Recalculation	Am RSAL 10/01 Task 3 Report	Am RSAL 4/02 Task 3 Recalculation
Wildlife Refuge Worker	862	780	132	142
Rural Resident Adult	209	232	32	42
Rural Resident Child	244	251	37	46
Open Space User Adult	11797	3617 *	1801	658 °
Open Space User Child	4842	1205 °	739	219 °
Office Worker	2289	1598 *	350	290 °
RAC Resident Rancher	45	NA	7	NA

Summary Table of Recalculated Values for Sum-of-Ratios Plutonium and Americium RSALs at Rocky Flats April 2002 — Sum of Ratios Values expressed in picocuries per gram

### Discussion

The relative increase in values for Americium RSALs for all scenarios is primarily due to the use of an equilibrium ratio for americium (18 2%) representing complete ingrowth at the point of computation of the sum of ratios reference values. The previous calculation used a ratio of 15 3% based on a composite of recent field measurements

The significant decrease in RSALs identified by asterik (\*) is due to a revision in the soil ingestion values for the Open Space User and Office Worker scenarios to make the contaminated soil ingestion amounts consistent with values used in the risk calculations. The previous computations did not correctly incorporate this scenario assumption

The remaining changes in computed RSALs are primarily due to the use of an adult soil ingestion distribution for the adult scenarios, the use of the higher americium-to-plutonium ratio in the sum-of-ratios calculation, and the use of 1 000 observations per computation as opposed to the 10 000 observations used previously. These changes are not seen as significantly different within the uncertainty of the model calculations.

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### **DRAFT**

### ADDENDUM TO TASK 3 REPORT

COMPUTATIONS OF RSALS FOR URANIUM CONTAMINATION AT ROCKY FLATS USING RESRAD 6 0 (DOSE BASED COMPUTATIONS)

### **Executive Summary**

Uranium contamination at Rocky Flats is primarily present as subsurface hot spots of relatively small areas of uncertain extent To address this conservatively, the Working Group elected to model a hypothetical area of surface contamination both large enough (5 acres) and deep enough (50 centimeters) to assure pathway saturation for all principle pathways for the residential and wildlife refuge worker scenarios. Since a relatively broad range of isotopic ratios of uranium isotopes have been used at Rocky Flats, the Group performed the RSAL calculations for the two bounding situations (depleted uranium and 20% enriched uranium) and selected the RSAL which was most restrictive to assure adequate protection with a single criterion Toxicity of uranium to the human kidney necessitated the application of a test to assure that the radiologically based SAL would be adequately protective in the scenarios modeled Most of the parameters for the computations are the same as for the plutonium and americium calculations, the principle exception being the use of a lognormal distribution for the plant uptake fraction for uranium, which is observed to be quite variable, influenced by a number of factors such as soil type, plant species type, weather, etc The principal pathway for the residential scenario is the plant ingestion pathway, which contributes 50-90% of the dose. For the wildlife refuge worker, the principal pathway is the external exposure pathway. In both cases the single criterion for the enriched uranium (31 micrograms per gram for the adult resident, and 225 micrograms per gram for the wildlife refuge worker for the RESRAD dose based computations) proved to be adequately protective both radiologically and toxicologically Since these criteria were computed using very conservative modeling assumptions (large area of surface contamination) compared to the actual situations to be encountered (small area hot spots of primarily subsurface contamination), the use of hot spot criteria could be considered, to give a more realistic, although still conservative clean-up level

### Introduction

The problem of uranium contamination at Rocky Flats is fundamentally different from the problem of plutonium and americium contamination that has been addressed in the body of the Task 3 Report Based upon the information that the Working Group had available the differences may be summarized as follows

• Uranium contamination occurs in a number of isolated spots at known locations on

the site where processing or disposal activities took place. The actual areas of the spots (solar ponds, burn pits, trenches, etc.) are uncertain but estimated to be less than 100 m2 per spot.

- With few exceptions all of the uranium contamination on the site is subsurface contamination, covered by uncontaminated soil. Available subsurface characterization data appear sketchy
- Two distinct types of uranium were processed at Rocky Flats depleted uranium, and enriched uranium (presumably of varying degrees of enrichment) Disposal activities of each type appear to have been conducted in different locations, with the possibility of a few locations where both types are present.

In the dose and risk based calculations which the Working Group undertook, the decision was made to not consider groundwater dependent pathways for the scenarios modeled, which were the three principle scenarios from the Task 3 Report — the wildlife refuge worker, and the rural residential (both adult and child) scenario — The decision to suppress groundwater dependent pathways was based upon the premise that the available shallow groundwater is insufficient in both quality and quantity to supply a resident, and would not be used by a refuge worker

In the absence of groundwater pathways, the current situation of buried contamination in small isolated hot spots presents only incidental exposure routes to either residents or refuge workers, unless the contaminated material is brought to the surface. In that case the material would constitute an exposure hazard to either an adult or child rural resident (as described in the Task 3 Report) through the same four pathways considered (external exposure, inhalation, homegrown plant ingestion, and soil ingestion). The wildlife refuge worker would also be exposed to the same three pathways (external exposure, inhalation and soil ingestion) as described in the Task 3 Report for plutonium and americium.

### **Approach**

A fundamental difference between the uranium problem and the plutonium problem, assuming that the buried uranium is moved to the surface, is that the area of surface contamination would be much smaller, and much more uncertain in extent, than that of the current surface plutonium contamination on the site, which is fairly well known. Although the Task 3 sensitivity studies showed that the area of the contaminated zone is not a sensitive parameter over the ranges considered appropriate for plutonium (acres to hundreds of acres range), exploration of the sensitivity of this parameter for uranium over areas typical of hot spots shows that in the range from 1 - 100 m<sup>2</sup> it is highly sensitive, and from 100 - 1000 m<sup>2</sup> it is moderately sensitive, since some of the more important pathways (plant ingestion and external exposure) are not saturated. This is easy to understand for the most significant pathway for residential exposure to uranium — the plant ingestion pathway. To supply a residential family

with home-grown food sufficient to provide the majority (or all) of their fruit and vegetable intake for year long periods, a sizable garden is required, on the order of 1000 -2000 m<sup>2</sup>. If only a small area of this garden is contaminated because of a small hot spot, then a correspondingly small fraction of the dietary intake is contaminated — and this will significantly impact the calculation of soil concentrations that meet the target dose or risk

Faced with the two sources of uncertainty of how much contamination would reach the surface from small buried sources, and the areal extent of such surface contamination, the Working Group chose to address this problem by developing an RSAL for a hypothetical situation of a large area of surface contamination (five acres). The Working Group believes that the approach of modeling a hypothetical large area as a surrogate for a much smaller real area of uncertain size is quite conservative. The three scenarios that were considered for this computation were the Rural Resident (adult and one year old child) and the Wildlife Refuge. Worker. With the exception of the contaminants considered, dose conversion factors, area and depth of the contaminated zone and the plant uptake factors (see below), all input parameters, including distributions, were the same as used in the plutonium/americium computations for these scenarios.

A second way in which the uranium calculation differs from the plutonium calculation has to do with the presence of both depleted uranium (DU) and enriched uranium (EU) at Rocky Flats. The isotopic mix of the three uranium isotopes (mass numbers 238, 235 and 234) strongly influences the sum-of-ratios RSALs. For this reason the Working Group has chosen to compute the single radionuclide RSALs using probabilistic RESRAD 6.0, for each of the three isotopes for each scenario, then to compute separate sum-of-ratios RSALs for the case of depleted uranium and enriched uranium, hereafter referred to as DU and EU respectively. For the degree of enrichment (of U235 by weight), the working group chose 20%, since the isotopic activity ratios of the three isotopes remain fairly constant above this enrichment.

For uranium, there is an additional consideration of chemical toxicity. Depending on the isotopic mix of the three principle uranium isotopes (see below), and the resulting activity per unit mass of the resulting mixture, compliance with the radiologically based protective criteria may not be sufficiently protective to assure that the resident would not exceed the safe limit of daily intake of uranium from ingestion of plants and soil (the two active ingestion pathways). This safe limit, referred to as the Reference Dose (RfD), was taken from the Superfund Integrated Risk Information System (IRIS), and represents an average daily intake, which if taken over a long-period of time provides adequate assurance of no chronic adverse effects on the human kidney (proteinuria). The Reference Dose for uranium is 3.0 micrograms per day per kilogram of body weight. Consideration of the chemical toxicity in addition to the radiological protective criterion necessitates that an additional test be made on the calculated RSAL quantities. This test requires that the internal exposure (inhalation and ingestion) components of the modeled annual dose (25 mrem) do not result in average daily intakes exceeding the Reference Dose. If the Reference Dose is exceeded in either the case of depleted or enriched uranium, then additional reductions must be applied to one or both RSALs. This reduction assures that the soil action

level does not result in potential average daily intakes that exceed the Reference Dose throughout the range of isotopic mixtures considered.

The final step in the computation of the RSAL for uranium involves the selection of a single value, in micrograms per gram, of either the toxicity-adjusted values for depleted or enriched uranium, whichever is most restrictive. The specification of total uranium by mass (micrograms per gram) instead of specific activity (piccouries per gram) is a useful convention which allows a single protective criterion to be specified for uranium which is independent of the isotopic mixture, allowing it to be more easily measured in field samples.

### Mass and Activity Relationships of Uranjum

Most of the information below was taken from the DOE Publication Health Physics Manual of Good Practices for Uranium Facilities (EGG-2530, UC-41, June 1988) It is important to distinguish between the percentage of each isotope by weight and by activity. The following table was constructed by taking information from Table 2-1, and from approximate values read from the graph in Figure 2-1 of the subject document.

Isotope	DU weight %	EU weight %	DU activity %	EU activity %
U-238	99 75	79 95 (est)	70	4
U-235	25	20	1	6
U-234	0005	05 (est)	29	90

Table A - Weight and Activity Relationships for Depleted and 20% Enriched Uranium

One of the striking points that can be seen is the amount of U-234 activity present in enriched uranium. This is because it concentrates faster than U-235 in the gaseous-diffusion enrichment process (which favors lighter isotopes), and because its half-life is much shorter than the other two isotopes (activity per gram much higher, or inversely grams per unit of activity much lower)

An empirical formula from the Good Practices Manual relates specific activity to degree of enrichment

$$S = (0.4 + 0.38E + 0.0034E^2)x10^{-6} Ci/g$$
 where  $E = percent enrichment$ 

The specific activity for DU (0.2% U235) is 4E-7 Ci/g, and for 20% EU it is 9E-6 Ci/g. The conversion factors from total activity (pCi) to mass (micrograms or ug) are therefore

These factors were used to convert total activity of the three isotopes in a given mix to mass in micrograms, and to check whether the toxicity based limit (i e the Reference Dose) is exceeded for the uptakes (in picocuries) associated with the dose and risk calculations

### **Dose Conversion Factors**

Isotope	DCF Type	DCF Adult (mrem/pC1)	DCF Child, Age 1 (mrem/pC1)
U-238	ıngestion	000165	00044
	mhalation (M)	0106	0344
	ınhalatıon (S)	03	0938
U-235	ingestion	000172	000475
	ınhalation (M)	011	0355
	ınhalatıon (S)	031	0948
U-234	ingestion	00018	000478
	ınhalation (M)	013	0409
	ınhalatıon (S)	035	108

Table B ICRP 72 Dose Conversion Factors for Uranium (Values in bold were used in these calculations)

- ICRP 72 (DCFs for Members of the Public) lists only one choice for an ingestion DCF for each uranium isotope (Age specific different values for age categories 3 months, 1 year, 5 year, 10 years, 15 years, and adult) The DCFs that were used in these calculations are for the adult and 1 year old child (consistent with the Task 3 calculations)
- ICRP 72 lists 3 choices (F, M<sup>1</sup>/<sub>2</sub> and S) based on fast medium and slow absorption from the lung to the blood for **inhalation** DCFs for each uranium isotope (Age specific as above) The most conservative DCFs for all uranium isotopes (i e highest dose per picocurie inhaled) are those of the S Absorption Type
- Per ICRP 71 guidance, chemical form alone is not to be used as a sole basis for selection of absorption type in the case of environmental exposure. The studies cited for animals suggest that UO<sub>2</sub> behaves as Type S, other uranium oxides (e.g. UO<sub>3</sub>, U<sub>3</sub>O<sub>8</sub>) show variability between Types M and S, and most other compounds show variability between Types M and F. The recommended default Type in the absence of site specific information is Type M.
- Although there is a significant difference in the value of DCF between the M and the S Absorption Types for each uranium isotope, there is very little impact on dose calculations using RESRAD Typically 99% of the dose computed in residential

scenarios is due to external gamma exposure and plant ingestion, with less than 1% due to inhalation

### Pathway and Parameter Sensitivity

Deterministic RESRAD runs were done using an adult residential scenario (external, inhalation, soil and plant ingestion pathways active). Single isotope RSALs were calculated for each of the 3 isotopes using ICRP 72 DCFs (Type M for inhalation), and varying the area of the contaminated zone between 100 and 40,000 m2. In addition, the depth of contamination was varied between 1 and 100 cm to observe the effect on the external gamma exposure component (Since the RSAL for this problem is calculated for a hypothetical situation of large area, the Group felt it was also important to set the depth of contamination at a point where subsurface contamination no longer contributes measurably to external gamma exposure.) The majority of RESRAD parameters at this level of investigation were default values. The following were observed.

- Year 1 gives the lowest RSALs using the default erosion rate and hydrological parameters
- For U238 and U235, the external exposure pathway dominates (60-98% of dose in first year), with the plant ingestion pathway making up essentially the rest
- The depth of contamination affects the surface exposure rate up to approximately 40 centimeters. Deeper levels of subsurface contamination are effectively shielded and do not contribute to the external gamma or any other water independent pathway. The Group decided to perform all future uranium calculations using a point estimate of 50 centimeters (to be conservative) for hypothetical depth of contamination.
- For U234, the plant ingestion pathway dominates (80 -90%) throughout the time frame, followed by soil ingestion (10%) and inhalation (7%)
- When the plant ingestion pathway is significant, it is sensitive to the area of the
  contaminated zone in the range tested (You need a big enough garden to grow
  contaminated produce) However, the external gamma pathway is saturated at small
  areas, on the order of 300 m2

Isotope	RSAL for Area 100 m2	RSAL for Area 1000 m2	RSAL for Area 40,000 m2
U-238	455	246	237
U-235	85	66	65

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1 77.004	4007	EAR	507
l U=2.54	1 <del>4</del> 927	327	1 320 i

Table C Effect of Area on Single Isotope Potential RSALs (sensitivity investigation - units pC1/g)

If only U238 and U235 were considered for small hot spots, the implication is that external exposure completely dominates the dose, with plant ingestion making a relatively small contribution. For U234, the plant ingestion pathway dominates, implying that plant ingestion becomes more important with a uranium mix having significant U234, such as enriched uranium. With the possibly of calculating RSALs for larger areas, and considering the variability of the plant uptake fraction, the importance of the plant ingestion pathway also increases

From the above it can be seen that it is necessary to consider the isotopic mix for uranium when establishing pathway and parameter sensitivity, since the constraints of the isotopic mix significantly affect the relative importance of plant ingestion and external exposure pathways. The next series of calculations were performed using isotopic ratios associated with depleted uranium (DU - activity ratios of U238 U235 U234 = 70 1 29), and 20% enriched uranium by weight (EU - activity ratios 4 6 90). The pathway contributions to total dose are displayed for large (40000 m2) and small (100m2) areas. For all calculations the thickness of the contaminated zone is 0.5m, the gamma shielding factor is 0.4, and the plant uptake fraction is 0.02. Note that the plant uptake fraction used for sensitivity studies is almost 10 times higher than the RESRAD default.

Pathway	% dose DU100	% dose DU40K	% dose EU100	% dose EU40K
Plant Ingestion	30 07	76 02	44 31	84 54
External Exp	68 39	20 89	53 38	12
Soil Ingestion	1 15	2 91	17	3 24
Inhalation	0 39	0 19	0 61	0 22

Table D Pathway percentage contribution for four conditions - sensitivity studies

The importance of the plant ingestion pathway significantly increases over the singleisotope sensitivity investigations for uranium for four reasons

- The plant uptake factor has been increased by a factor of 2 over what was previously modeled
- There is a significant contribution when realistic combinations of all three isotopes are included, particularly U-234 which contributes to ingestion pathways but not to

external exposure pathways

- The gamma shielding factor has been reduced to 0.4 (the current default value for the EPA Soil Screening Guidance) Selection of this value reduces the contribution from external exposure Previous calculations used 0.7, the RESRAD default
- Areas large enough to saturate the plant ingestion pathway are being considered

The increasing importance of ingestion introduces the need to establish a good value or distribution for the plant uptake fraction, and also the need to consider uranium toxicity as well as radiological dose and risk. Consistent with the approach used for the plutonium calculation, the Working Group used the same distributions for plant ingestion quantities, and also investigated the variability of the plant uptake factor for uranium through a review of the literature. This investigation resulted in the selection of a lognormal distribution for the plant uptake factor having a 95<sup>th</sup> percentile value of 00645 (a factor of 2 6 times higher than the RESRAD default value - see below)

Soil ingestion is addressed by use of the same distributions for adult resident, child resident and wildlife refuge worker as used in the Task 3 Report. Recall that the adult soil ingestion rate is represented as a uniform distribution (all values from maximum to minimum have equal probability) with minimum value 0 and maximum 130 milligrams per day for adults (0 - 47.45 grams per year - see below). This ingestion rate of contaminated soil is assumed to occur over a 24-hour period for each day that the adult resident is on the site, but over an 8-hour workday for each day the wildlife refuge worker is on the site. Owing to the way that RESRAD apportions the intake of contaminated soil over the course of a year, it is necessary to introduce the uniform distribution (0 - 47.45 grams/year) for the resident and (0 - 142.35 grams/year) for the refuge worker, to ensure that the above conditions are met

To summarize the sensitivity studies, the Working Group has concluded that the same fixed and distributed values of parameters should be used in the uranium calculations as for the plutonium and americium calculations, with the addition of a different approach for the area of the contaminated zone (use of a hypothetical 5 acre contaminated zone), use of 50 cm for depth of the contaminated zone as opposed to 15 cm for the Task 3 calculations, and the introduction of a distribution for the plant uptake fraction for uranium

### **Determination of Plant Uptake Fraction Distribution for Uranium** (To be inserted)

### **Computation Procedure**

For each scenario a separate RESRAD 6 0 run was performed using 1000 observations for each of the three uranium isotopes, initially present at 100 pCi/g. From the dose distribution table the total dose from uniform contamination of 100 pCi/g corresponding to 95% cumulative probability was read off for the year of maximum dose (year 0 in all cases). This dose was used

to scale the single radionuclide soil concentration to that which would result in 25 mrem annual dose This value is expressed as the single nuclide RSAL in Tables E, F and G Following this, the sum-of-ratios RSALs for depleted uranium (70 1 29 isotopic ratios) and 20% enriched uranium (4 6 90 ratios) was calculated for each scenario, and also presented in Tables E, F and G This run was also used to establish the fraction of the total dose of 25 mrem which was attributable to ingestion (combined soil and plant ingestion), for comparison with the toxicity Reference Dose The inhalation component was ignored in this calculation since the inhalation contributions for both scenarios were less than 1% of the total dose. The ingestion component (expressed as mrem/yr) was converted to micrograms per kilogram per day. This component is calculated by dividing the mrem/yr ingestion component by the average ingestion DCF of 0 00017 mrem/pC1 for adults or 00046 mrem/pC1 for children (from Table B), multiplying that result by the appropriate conversion factor for DU or EU in micrograms per pCi, and scaling to an average daily intake for a 70 kilogram adult or a 15 kilogram child. These results are presented in Tables E, F and G as well The average daily intake per kilogram of body weight is scaled from the annual mass intake by dividing by the number of exposure days per year for an RME individual (350 for a resident, 250 for a wildlife refuge worker) and dividing this result by 70 kg for an adult, or 15 kg for a child.

#### **Dose Computation Results**

Isotope	Single Nuclide RSAL	SOR RSAL (DU)	SOR RSAL (EU)
U 238	227 pC1/g	173 pCı/g	11 pCı/g
U 235	75 pC1/g	2 5 pCı/g	17 <b>p</b> Cı/g
U 234	350 pC <sub>1</sub> /g	72 pC1/g	254 pC1/g
	% of Dose Due to Ingestion	55%	71 6%
	Average Daily Intake (ug/kg/day)	8 25 ug/kg/day	0 5 ug/kg/day

Table E 95% Cumulative Probability Results for Rural Resident - Adult Scenario

Isotope	Single Nuclide RSAL	SOR RSAL (DU)	SOR RŞAL (EU)
U 238	254 pC1/g	194 pCı/g	13 pCı/g
U 235	78 pCı/g	2 8 pC1/g	19 pCı/g
U 234	401 pC1/g	80 pC1/g	284 pCı/g
	% of Dose Due to Ingestion	70%	71 6%
	Average Daily Intake (ug/kg/day)	167 ug/kg/day	0 74 ug/kg/day

Table F 95% Cumulative Probability Results for Rural Resident - Child Scenario

Isotope	Single Nuclide RSAL	SOR RSAL (DU)	SOR RSAL (EU)
U 238	1059 pC1/g	915 pC1/g	81 pC1/g
U 235	221 pCı/g	13 pC1/g	122 pCı/g
U 234	4901 pCı/g	379 pC1/g	1826 pC1/g
	% of Dose Due to Ingestion	14 7%	35 7 %
	Average Daily Intake (ug/kg/day)	3 1 ug/kg/day	0 3 ug/kg/day

Table G 95% Cumulative Probability Results for Wildlife Refuge Worker Scenario

#### Discussion

• The sum-of-ratios RSAL values for DU and EU can be expressed as total uranium in micrograms per gram of soil

Scenario	DU RSAL	EU RSAL
Adult Resident	619	31
Child Resident	692	35
Wildlife Refuge Worker	3268	225

Table H Sum of ratios RSAL

 In all scenarios, the DU radiological SALs result in exceeding the RfD for toxicity If the SAL s are scaled to values which do not exceed the RfD, the following results occur

Scenario	DU SAL	EU SAL
Adult Resident	225	31
Child Resident	124	35
Wıldlıfe Refuge Worker	3163	225

Table I Soil action level accounting for toxicity

• The most restrictive adult residential RSAL for total uranium is that which is radiologically based on enriched uranium. The value of 31 ug/g for this SAL is above the range of normal background levels for uranium (Note that background uranium is

usually in a natural isotopic ratio very different than that of enriched uranium)

- For the presence of institutional controls, the most restrictive Wildlife Refuge Worker RSAL is for enriched uranium at 225 ug/g
- The plant ingestion pathway is the greatest contributor to dose for residents. This is primarily due to the broad distributions used for leafy and non-leafy plant ingestion quantities, and to the use of the broad distribution for plant uptake factor.

# RFCA Stakeholder Focus Group Attachment E

Title October 3, 2001 RFCA Focus Group Meeting

Minutes

Date April 12, 2002

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### RFCA STAKEHOLDER FOCUS GROUP OCTOBER 3, 2001 MEETING MINUTES

#### INTRODUCTION AND ADMINISTRATIVE

A participants list for the October 3, 2001 Rocky Flats Cleanup Agreement (RFCA) Stakeholder Focus Group meeting is included in this report as Appendix A

#### **AGENDA**

Reed reviewed the agenda

- Final Results from RSAL Modeling Scenario Descriptions, Key Parameter Values, Results, Implications
- Continued Briefing and Discussion on Pathway Contributions to End Results
- Policy Discussion Tiers
- RSAL Path Forward Task 3 Report, Meeting with Principals, etc.
- Wind Tunnel Technical Review Update

# RSAL PATH FORWARD - TASK 3 REPORT, MEETING WITH PRINCIPALS, ETC

Joe Legare, U.S. Department of Energy (DOE), briefed the Focus Group on the status of the Radiological Soil Action Level (RSAL) Task 3 report, Calculation of Surface Radionuclide Soil Action Levels for Plutonium and Americium DOE and the Colorado Department of Public Health & Environment (CDPHE) are conducting the technical editing. All of the references are being incorporated.

The Focus Group discussed Denver's total suspended particulate (TSP) make-up and the concentration of particulate matter measured in micro grams (PM-10). In general, PM-10 is typically 10 to 25 percent of TSP for an urban area such as Denver. One Focus Group member responded by stating that other studies have indicated much higher concentrations of PM-10, as high as up to 50%. This discussion item was deferred until data can be presented to support this discussion.

No new information was reported regarding the meeting with the principals

# FINAL RESULTS FROM RSAL MODELING—SCENARIO DESCRIPTIONS, KEY PARAMETER VALUES, RESULTS, IMPLICATIONS

Steve Gunderson, CDPHE, presented the "Preliminary Dose & Risk Calculations for Plutonium in Surface Soil—Adjusted by Sum-of-Ratios Method (pCi/g)" table This table, previously provided, was updated to include additional scenarios modeled using and US Environmental Protection Agency (EPA) standard risk equations These additional scenarios include

- Open Space User adult,
- Open Space User child, and
- Office Worker

The risk level for Open Space User (adult/child) was determined using standard EPA risk equations. As reflected in the table, there is only one risk level calculated for both the adult and child Open Space User. It was determined that the 30-year exposure to a child would be representative of the 30-year exposure to an adult.

The Open Space User and the Office Worker scenarios were modeled to address a current requirement in the Rocky Flats Clean-Up Agreement (RFCA). The Office Worker scenario assumes that the office is enclosed and located in the southern part of the industrial area at the Rocky Flats Environmental Technology Site (RFETS). The table shows risk levels and annual dose data for the purpose of providing information, but will not be used in the final determination of RSALs.

In terms of RSAL and cleanup determinations, risk and dose results from key scenarios such as the Wildlife Refuge Worker and the Rural Resident will be used to establish clean up levels. Risk levels are calculated at 10-4 (1 in 10,000), 10-5 (1 in 100,000) and 10-6 (1 in 1,000,000).

A Focus Group member suggested three other methodologies for arriving at risk and dose levels

- 1 Use Risk Assessment Corporation's (RAC) metabolic and behavioral parameters, which are fixed parameters that include duration, breathing rate, soil ingestion combined with the RSAL's Working Group physical parameters, such as soil density and hydraulic parameters,
- 2 Duplicate the RAC's approach when modeling with RESRAD, or



3 Allow Focus Group members to model with different parameters

CDPHE asked for review of the Task 3 report first before any further work is conducted EPA stated that on EPA's main web page there is a capability to model using different scenarios and parameters for radionuclides. Information such as wind speed and climate are needed so the website will produce a number for risk

Reed explained an important distinction—the data this group are working with are a combined analysis for Plutonium (Pu) and Americium(Am)—The current risk calculations use a "sum of ratios" method with an Am Pu ratio of 0 1527—This ratio was derived during the characterization work performed on the 903 Pad and the lip area Earlier risk calculations were based on an activity ratio of 0 1364—Using the updated activity ratio results in a slightly lower sum of ratios value for plutonium

CDPHE said that the calculations for Uranium would be based on the work previously conducted by the Risk Assessment Corporation (RAC) Uranium analysis is considered unique due to its solubility. The issue is that risk models do not have the capability to evaluate groundwater contaminated with Uranium in an acceptable way.

The Focus Group discussed "rounding to significant figures". The Am Pu ratio is given to four significant figures. CDPHE stated that the final numbers will be rounded to one or two significant figures. EPA explained that Rocky Flats does not have just one Am Pu ratio, but that several site-specific ratios exist.

A Focus Group member asked what types of adjustments will be made to the RSAL for the varying combinations of Pu and Am

EPA and DOE responded that the actual RSALs would not be adjusted, but the ratio of Am Pu will be adjusted to reflect what actually exists. In areas where there are spills or where erosion exists near surface water, soil action levels will be dealt with very carefully

The Focus Group transitioned to the RAC resident scenario. One Focus Group member observed that the scenario would be modeled using RESRAD to produce dose value only, and that no risk values would be calculated. The Focus Group made observations about the applicability of the RAC's approach to RESRAD. Some of the data conversions are difficult due to differences in exposure duration, etc. One model uses hours per day and the other is based on annual exposure data.

Reed Hodgin, Facilitator, summed up the discussion by stating that the agencies are using the resident rancher scenario as a way to compare model against model for the previous analysis to the current analysis. This Focus Group is concerned with distinctions in approach and how historical approaches compare with current scenarios.

CDPHE commented that the RFCA does not include Rural Resident as a scenario

Reed stated that since the Rural Resident scenario is not driven by regulations, it is being modeled using a dose parameter instead of risk guidelines to gain a perspective

CDPHE added that at a 25-mrem dose value, the risk value is above 10<sup>-4</sup> (1 in 10,000) for all scenarios. It was agreed that the 25-mrem dose value would be calculated, and if risk values fell outside of the risk range, they wouldn't be used further

CDPHE also stated that Rocky Flats is subject to critical requirements. These requirements were based on the actions taken by the State of Colorado in response to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) threshold, balancing and modifying criteria, as well as the Applicable or Relevant and Appropriate Requirement (ARAR). The State of Colorado developed a policy to incorporate the Nuclear Regulatory Commission guidance by using 25-mrem dose under the ARAR requirement. Also, the use of EPA risk ranges is consistent with CERCLA and ARAR requirements.

#### **GROUP DISCUSSION**

#### Air Concentrations in Colorado

Bob Nininger, Kaiser-Hill, LLC, discussed air concentrations in Colorado and specifically at Rocky Flats Particulate matter in the air exists in a full range of particle sizes, from very large particles which fall out immediately, to sizes small enough to be considered gaseous. For our purposes, particles are measured in two important size ranges.

- 1 Total Suspended Particulates, those particles less than about 50 micrometers (μm) in diameter that can remain suspended above the ground for extended periods of time, and
- 2 PM-10, those particles which are small enough to penetrate deeply into the human respiratory system, potentially causing adverse health effects

At Rocky Flats, using standard EPA sampling techniques, PM-10 represents approximately 37% of TSP

Particulates in the atmosphere also group into primary aerosols and secondary aerosols Primary aerosols are those that are emitted directly into the atmosphere from a source One class of primary aerosols originates from geological sources (dust, soil, building materials, etc.) These particulates tend to be relatively large and dominate the TSP size range. This type of particle dominates the atmospheric content at Rocky Flats. Another type of primary aerosol is combustion-produced particulates. These particles are released from fuel burning, automobile exhaust, industrial foundries, etc. and usually are carbon-based. Smaller by the nature of their formation, they are usually found in the PM-10 size range.

Secondary aerosols are those that are formed while transporting through the atmosphere. These aerosols are usually produced through chemical reactions among pollutant gases, and are almost always found in the smaller end of the PM-10 size range. Secondary aerosols are primarily responsible for the Brown Cloud pollution effect experienced in the Denver area.

Bob explained sampling efficiency in collecting particulate samples. All air samplers have smooth cut-points, meaning that they are imprecise (to varying degrees) in capturing exactly the particle size desired. This is a function of the physics of small particles and how they behave in airflows. Thus, a PM-10 sampler will capture some particles that are larger than  $10\mu m$ , a TSP sampler measures particles "approximately" smaller than  $50\mu m$ 

### **QUESTIONS FOR POLICY DISCUSSION**

The group developed several policy discussion questions

- 1 Define the depth of "surface"
- 2 Where does subsurface contamination begin?
- 3 Which activities are assumed for subsurface?
- 4 How much area impacts subsurface?
- 5 Quantify organics and inorganics
- 6 How much subsurface contamination will remain?
- 7 What are the subsurface risks?
- 8 How will the water balance affect subsurface pathways? The Focus Group evolved the concept of establishing a two-tiered RSAL structure CDPHE felt it was

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important to clearly define and document the tier development process to include the implications for long-term stewardship and decision-making methods

The City of Westminster felt discomfort with the tier levels and the fact that ranges do not exist. Additionally, the City of Westminster would like to see very ambitious clean-up depths up to 3 feet, rather than the proposed 6 inches

A Focus Group member stated that the most conservative, unrestricted scenario should be the priority

Another member stated a preference for the tiered approach and felt that Tier 1 ought to represent the most stringent cleanup using the latest technology Additionally, Tier II needs to be a component of long-term stewardship and cleanup to average background using fiscally and technologically feasible strategies in an environmentally responsible manner

Another member added that, in order to define a tiered system, an understanding of how As Low As Reasonably Achievable (ALARA) applies to RSALs and Stewardship needs to occur The member sees this as an opportunity to work with DOE, EPA, and CDPHE in crafting a cleanup that meets a myriad of interests

The Focus Group generated Tier ideas as follows

- Tier 1 involves removal,
- Tier 2 involves control,
- Strict cleanup is needed where there is a pathway contribution,
- Less strict cleanup can be applied where there is no pathway contribution,
- Vary levels of cleanup by risk via pathway contribution,
- Define implementation of cleanup strategies,
- Define subsurface strategies for cleanup,
- Define and understand ALARA applicability and Stewardship as it relates to cleanup to background level

The Focus Group further discussed the fact that most of this discussion has been conceptual, and that the long-term goal is to have a system in place, a post-RFCA agreement, a post-robust stewardship agreement, and a process to analyze risk at the subsurface level

#### OTHER DISCUSSION ITEMS

The Focus Group should expect the Task 3 report for the October 30<sup>th</sup> public meeting at the Westminster Recreation Center. The report will be issued for formal public comment in November. Progress in the Uranium and tiering discussion needs to occur. A final report may be published early 2002.

In terms of onsite water quality, the sampling methodology is being evaluated and a dialog needs to occur

#### WIND TUNNEL TECHNICAL REVIEW UPDATE

Reed Hodgin, facilitator, explained that two questions were posed to the technical reviewers. To evaluate the appropriateness of wind tunnel technology used for the studies at Rocky Flats for developing resuspension values for use in establishing RSALs,

- 1 Is the technology appropriate for wind tunnel studies and did Midwest Research Institute (MRI) apply it in the right way, and
- 2 Are the results being properly used in developing input values for RESRAD modeling?

This technical review asked for a technical analysis of methodologies and approach The reviewers will use documents and information provided by the agencies Each reviewer was asked to develop and submit a written report containing their evaluation and justification

Reed stated that a budget has been established and funding is available for this technical analysis. Three reviewers have agreed to respond to date

## **ADJOURN**

The meeting adjourned at 6 30 p m

# RFCA STAKEHOLDER FOCUS GROUP OCTOBER 3, 2001 MEETING MINUTES

APPENDIX A
PARTICIPANTS LIST

# Participation List for RFCA Focus Group Meeting of 10/03/01

First	Last	Company Organization
Melissa	Anderson	RFCLOG
Sean	Bell	DOE/RFFO/OCC
Christine	Bennett	AlphaTRAC, Inc
Kent	Brakken	US DOE - RFFO
Lane	Butler	Kaiser-Hill Company, LLC
Kımberly	Chleboun	RFCLOG
John	Corsi	Kaiser-Hill Company, LLC
Carol	Deck	Kaiser-Hill Co, LLC
Shirley	Garcia	City of Broomfield
Joe	Goldfield	RFSALOP
Steve	Gunderson	CDPHE
Mary	Harlow	City of Westminster
Jerry	Henderson	RFCAB
Reed	Hodgin	AlphaTRAC, Inc
Victor	Holm	RFCAB
Ken	Korkıa	RFCAB
Michelle	Kump	RFCAB
Ann	Lockhart	CDPHE
Carol	Lyons	City of Arvada
Bob	Nınınger	Kaiser-Hill Company, LLC
Tım	Rehder	US EPA
Carla	Reliergert	Weston
Kathleen	Rutherford	CDPHE/HMWMD
Mark	Sattelberg	US Fish and Wildlife Service
Kathy	Schnoor	City of Broomfield
Joel	Selbin	~ v v v v
Dave	Shelton	Kaiser-Hill Company, LLC
Honorable Hank	Stovall	City of Broomfield

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